Sonography of Plantar Warts
Role in Diagnosis and Treatment

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Objective. The purpose of this presentation is to show the sonographic morphologic characteristics of plantar warts and the scope of sonography in the treatment of these lesions. Methods. We retrospectively reviewed 27 sonographic examinations of the plantar region; 17 corresponded to plantar warts diagnosed by dermatologists in which the diagnoses were medically derived from sonographic examinations after failure of their treatments. The remaining group consisted of 10 healthy individuals. Sonograms were compared with standard histologic findings. Results. The sonographic features of normal plantar skin and plantar warts are described, including the shape, echogenicity, pattern of growth, involvement of skin layers, and blood flow in the lesions. Conclusions. Sonography may be considered as reliable support for plantar wart diagnosis and may have a role in the evaluation of plantar wart treatment modalities, allowing monitoring of therapeutic responses, especially in recurrent and difficult cases with persistent symptoms such as pain. Key words: dermatology; skin; sonography; wart.

Plantar warts are common ailments, the result of human papillomavirus infection of the soles of the feet. This wart virus elicits a benign epithelial proliferation that invaginates the plantar skin as a consequence of external pressure when standing or walking. On physical examination, plantar warts are most commonly seen as hyperkeratotic lesions. It is estimated that between 7% and 10% of the US population and up to 22% of children in parts of Australia are infected. Recurrence after treatment is common, and lesions may be very painful, producing a considerable impact on daily activities.

Clinical diagnosis is rarely considered a problem and is generally straightforward, but partially or previously treated lesions may be more difficult to diagnose, and skin imaging may be helpful, especially if pain remains at the same location after treatment. In these cases, it may be necessary to determine whether the pain is caused by insufficient treatment, a recurrence in the same site, or a different clinical entity complicating the evolution.
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High-resolution sonography clearly defines the skin layers with variable-frequency probes that go from 7 to 15 MHz, as well as deeper structures such as tendons, bursas, muscles, nerves, and vessels. This image presentation discusses and illustrates the sonographic morphologic characteristics of plantar warts.

Materials and Methods

A total of 27 plantar sonographic examinations were retrospectively reviewed; 17 of them corresponded to plantar wart lesions in 14 patients (8 male and 6 female) with a mean age of 28.3 years (range, 4–55 years). All of these cases had been referred by dermatologists after clinical examination and failure of their treatments. Histologic analysis was performed by an excisional biopsy in 94% (16 of 17) of the lesions, and in the remaining 6% (1 of 17), a punch biopsy specimen was obtained. The remaining group was composed of 10 healthy individuals (7 female and 3 male) with a mean age of 29.3 years (range, 20–47 years). In this control group, sonographic examinations were performed in the sole of the right foot at the level of the metatarsal joints (first and fifth metatarsal joints) in a transverse view as a reference.

This study was approved by the Ethics Committee of Clinica Servet, and all participants signed an informed consent form. The sonographic equipment consisted of an HDI 5000 system (Philips Healthcare, Bothell, WA) with a compact 7–15-MHz linear probe, and all sonographic studies were performed by the same radiologist (X.W.).

The patient was seated on a table with the knees fully extended and the feet in a neutral position. The compact linear probe was located on the lesion site, and a copious amount of gel was used as a conductor and to give an even distribution of the contact pressure. Figure 1. Sonographic technique used to approach a plantar wart lesion. The patient is seated on a table with the knees fully extended and the feet in a neutral position. A compact linear probe is located on the lesion site, and a copious amount of gel is used as a conductor and to give an even distribution of the contact pressure.

Figure 2. Transverse sonogram in a healthy control participant clearly showing the skin layers. D indicates dermis; E, epidermis; and ST, subcutaneous tissue.

Figure 3. Digital drawing of the foot (coronal axis) showing how the wart (W) grows inward. This lesion starts from the surface of the sole and goes deeper into the tissues (arrows). MTT indicates metatarsal.
Results

Normal Sonographic Features of the Plantar Skin

In the healthy participants, the plantar epidermis showed a bilaminar parallel hyperechoic structure with a virtual hypoechoic space in between; the mean epidermal thickness ± SD was 0.7 ± 0.1 mm. The dermis appeared as a hyperechoic band because of its high collagen content, with a mean thickness of 1.2 ± 0.3 mm. Subcutaneous tissue showed a hypoechoic structure given by fat lobules that were separated by hyperechoic fibrous septa. Blood flow observed in the control participants was predominantly confined to thin venous vessels that were present in the subcutaneous tissue. No notable arterial or venous vessels in the dermis were detected (Figure 2). There were no significant differences in the normal thickness measurements of the skin by using the first and fifth metatarsal joint levels during the sonographic examinations (epidermis, \( P = .128 \); dermis, \( P = .124 \)).

Sonographic Features of Plantar Warts

On sonography, all cases showed a fusiform shape and a hypoechoic, endophytic (ie, growing inward) structure that involved the epidermis and superficial dermis (Figures 3–7). In 47% (8 of 17) of the plantar warts, a focal decrease of the echogenicity in the superficial subcutaneous tissue was observed. The mean diameters of the lesions were as follows: in the transverse axis, 11.2 ± 4.6 mm (range, 4.6–15.9 mm); in the anteroposterior axis, 12.3 ± 5.8 mm (range, 3.9–19.4 mm); and the mean thickness was 3.7 ± 1.5 mm (range, 1.3–5.9 mm).

Multiple lesions (\( n = 3 \)) were detected in 1 patient, and they were located close to each other (Figure 8). In 3 cases, a 3-dimensional reconstruction of the lesion site was performed (Figure 9).

In 76.4% (13 of 17) of the lesions, arterial vessels were detected in the dermis at the bottom of the lesions, and the mean peak systolic velocity for these vessels was 9.5 ± 3.9 cm/s. The remaining 23.6% (4 of 17) of the cases did not show arterial vessels in the dermal component of the lesions,
and these cases corresponded mainly to the group of smaller lesions (Figure 10). Venous vessels were detected in the subcutaneous tissue with a distribution and size similar to those in the control participants.

After the sonographic examinations, 16 lesions underwent surgery, and 1 case underwent superficial curettage followed by medical treatment. This last case was monitored by sonography after 30 and 90 days of treatment and showed a regression of the lesion (Figure 11). After 1 year of clinical follow-up, there was no evidence of recurrence in any of our cases.

**Discussion**

Anatomic features of plantar warts, including their depth, are clearly recognizable on sonography, suggesting that this mode of imaging may be helpful in their diagnosis as well as for monitoring treatment in difficult cases or experimental noninvasive therapies.

A different blood flow pattern was detected on sonography when comparing normal and lesional skin in most cases. In healthy plantar skin, the blood flow was predominantly venous and easily visible in the subcutaneous tissue; in contrast, most of the warts had a focal increase in the arterial dermal flow. This last finding may have been related to inflammation either due to the presence of the lesion or secondary to treatment. All of our plantar wart cases had persistent pain at the lesion site as the main symptom, which also could have been related to the underlying inflammatory process previously mentioned.

Further investigations may be necessary to determine the potential of sonographic guidance for estimation of the effects of plantar wart treatment. As in the treatment of nonmelanoma skin cancer, this type of imaging may be of particular benefit after noninvasive therapy.

In conclusion, plantar warts have characteristic morphologic features that are recognizable on sonography. This technique can define their extent, exact locations, and blood flow patterns. Sonography may be extremely useful in difficult
cases, especially when symptoms such as pain persist over time. It also may give relevant presurgical information and, finally, may provide important insights into associated conditions of the foot.

Figure 7. Transverse sonograms of plantar warts (W) from different cases showing progressive levels of ingrowth going from low (A) to moderate (B) to high (C) extension of the lesion in the deep dermis. Abbreviations are as in Figure 2.

Figure 8. Transverse sonogram of multiple plantar warts in the same patient showing 2 epidermal and dermal lesions (W1 and W2) located close to each other. Both lesions have a hypoechoic fusiform structure.

Figure 9. Three-dimensional reconstructions of 2 different lesions going from low (A) to high (B) involvement of the epidermis, which becomes thicker with viral infiltration. Abbreviations are as in Figure 2.
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Figure 10. Color Doppler sonograms showing different patterns of vascularity in different plantar warts, going from absent (A) to moderate (B) to high (C) presence of arterial vessels in the deep dermal components of the lesions.

A

B

C

Figure 11. Sonographic guidance of plantar wart treatment. A, First sonographic examination after failure of medical treatment: transverse view showing a wart (thickness of the wart between markers) involving the epidermis and dermis with an invaginated growth dermal pattern. B, Second examination at 30 days. After superficial curettage, the wart (between markers) shows a decrease in its epidermal extent that is better outlined, but persistent invaginated growth is still visible in the dermis. C, Sonogram 90 days after a new medical treatment showing absence of the invaginated dermal component and recovery of the normal bilaminar hyperechoic appearance of the epidermis at the lesion site. Abbreviations are as in Figure 2.

A

B

C
References


